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ABSTRACT

The present report is the fourth of a series concerned with mental functioning and its development in early childhood. The study attempted to discover whether the same children tested at intervals of one or more years showed similar development in thinking ability from age to age. Longitudinal test protocols were obtained for 92 children at 3 years who were retested at 5 years and 55 children at 4 years who were retested at 5 years, making 147 children included for tests at the 5-year level. A questionnaire covering the environmental influence in the life of the 5-year-old was asked of each mother. Questionnaire results were analyzed to see what relationships to children's thinking ability could be found. Factor patterns were compared across the three age levels. Results indicate that five specific sorts of thinking ability can be identified. In general, the patterns of thinking shown by preschool children are retained throughout the three year age range. However, the pattern of development of each child varies not only in general rate of change but also for each aptitude. One clear implication of this study is that assignment to a "track" results in a great waste of potential because individual rates of development and different aptitudes vary so greatly from year to year. (WY)

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FINAL REPORT

Project No. 9-I-070

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A Longitudinal Assessment of Thinking Ability of Preliterate Children During a Two-Year Period

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Rachel S. Ball, Investigator

SUMMARY

Two other studies of preschool children preceded this research--that of three and four-year-old children from English speaking homes.

The objectives of this research involved an attempt to answer the following questions:

1. Do the same children tested at one or more year intervals show similar patterns of development from age to age? Is it possible to appraise differentially in five-year-old children mental operations and responses similar to the ones found in the same children at ages three and four years?

2. When the same three-year-olds were tested at five years, and the same four-year-olds were tested at five years, did they show the same patterns and rates of development? Is there a tendency for five-year-olds to show more rapid development over three and four-year-olds in convergent production than they do in divergent production at the earlier levels?

3. What relationships in development are shown by the child to the educational level of his parents, especially to the mother?

4. Does the amount of time spent by the parents with the children affect the scores on tests of their thinking ability that differentiate convergent and divergent production?

5. Which type of thinking is most affected by the environmental experiences of the child?

A questionnaire covering the environmental influences in the life of the five-year-olds was asked of each mother. These questions were analyzed to see what relationships could be found to the thinking ability of these children.

The test instrument used for evaluating the thinking aptitudes of the five-year-old children was similar in content to that of the three and four-year-olds, but was increased in difficulty in nine of the 18 tests. Hence, they were not comparable so that a reliability study could not be developed, although the factor patterns could be compared at the three age levels.

The longitudinal test protocols were obtained for the 92 children at 3 years who were retested at 5 years and the 55 children at 4 years who were retested at 5 years, making 147 children included for tests at the 5-year level.

The questionnaires asked of the mother were completed for all of their 147 children at the age of 5 years.

It proved to be more difficult to locate for retesting the children of mothers who had no more than ninth grade education, and only 11.5 percent of the children fell in this category. The high school graduates represented slightly more than one-half of the group at 58.5 percent, while 30 percent of the group had mothers who were graduated from college.

Because of the small numbers included in the two younger age groups, the results are far from conclusive although several are sufficiently differential to be significant.

The tests for each younger level were paired with the five-year level tests. Scoring of the protocols was done by the investigator. The scores were tabulated for computer treatment. The programming and computer work were done under the direction of Philip Merrifield, who had also been responsible for the computer work done on the three and four-year-old tabulations.

Principal factors were extracted. Although these axes were machine rotated to the varimax criterion, in some instances graphic rotations were used to lead to more meaningful simple structure. Factor scores were computed. Finally, the coded questionnaire items were correlated both with themselves and with the factor scores on the aptitude items. A factor analysis was made of the coded questionnaire items. All of these analyses offered many possibilities for comparison.

Findings: In each of the three age levels, five specific sorts of thinking ability were identified and, while the number of children was much smaller than in the earlier tests of three and four-year-olds, the aptitudes agreed fairly well. The five-year-old factor analysis was the first one made at this age level and was for a larger number of cases so that the results are somewhat more meaningful. More data are now being collected for five-year-olds and these will give, when completed, a much more adequate sample of this age level. A promax rotation at five years gave almost identical factors with the varimax rotation, indicating a tendency toward orthogonality in the distribution.

An intercorrelation matrix of the aptitudes at five and four years reflected the changes in the test items from four to five and also was affected by the small number of four-year-olds included in the study. The resultant correlation values were, on the whole, insignificant. Accordingly, it was decided to obtain factor scores at age five to compare with the questionnaire responses.

The questionnaire items were coded to a normalized five-point scale. Inspection of the distributions of responses indicated that more information could be extracted

from a correlational approach than from a contingency analysis or analysis of variance, so the questionnaire relations to aptitude are subsequently given in correlational terms.

Factor 1 of the questionnaire suggests a socioeconomic basis along with persistence in completing school. This group of items related positively to aptitude Factor 4, verbal reasoning, and with a hint of positive relationship to ability to organize spatial units.

Questionnaire Factor 3 involves strongly whether parents read to the child and also is related slightly with some over concern for his welfare as suggested by lesser loadings on, "When he was a baby, did parent pick up the child when he cried?" and on the question as to the number of traits the child displayed that caused the parents anxiety. This has been interpreted as "achievement-oriented, slightly apprehensive parental attitude." Interestingly, this parental attitude is related positively to the two aptitude factors dealing with a facility in space, the construction and transformation factors, but hardly at all to either semantic factor. So it appears that reading to a child does not seem to be related to his verbal performance aptitudes.

Factor 4 of the questionnaire can be labeled the "family-centered home" and it is unrelated to any aptitude factor; in other words, no specialized aptitude development can be predicted from the intellectual performances measured in this study.

The working mother is shown to have a negative relation to the verbal reasoning aptitude. One can only conjecture that the experiences of the child in her absence do not develop strength in that aptitude.

A few individual questionnaire items have interesting relations with aptitude scores.

1. In spatial aptitudes, girls do less well than boys.

2. Some indication that children do better in space construction if their father reads to them.

3. The Phoenix children rate higher in originality than the Detroit children.

4. Children who rate high in originality tend to have more anxious parents.

5. The homes having more children have some tendency for the five-year-old to have lower aptitudes in originality.

6. The mothers having higher education have children with higher aptitudes in spatial production of figural units.

7. The Detroit children tend to have lower scores on verbal reasoning aptitudes.

8. The children of working mothers tend to have lower scores in verbal reasoning aptitudes.

9. The Detroit children tend to score lower on aptitudes in spatial transformation, but higher on CMS verbal reasoning.

The four-year-old factors, in spite of the very small sample (N = 55), are quite similar to previous results for the earlier study of four-year-olds, and to the present study of five-year-olds, indicating reasonably unbiased results, at least with respect to the underlying factor structure.

The scores on tasks at age four and age five are correlated with discouraging results. Unfortunately, not only are the diagonal entries not large in an absolute sense, but, for many of the tasks, they are not even the largest of the column. Interpreting this result is difficult as it runs against the theory of continuity of development with regard to aptitudes. It might be expected that children who do relatively better than their peers on a specific aptitude at age four will also maintain their relative superiority at age five.

However, this is not the case. When aptitude measures at age three were used as predictors of factor scores at age five, the results showed some indication that three-year-old performances were precursors of five-year-old performances; however, the relationship is slight in every case--sufficient to claim statistical significance but not predictive utility for a single child.

One contributing cause of this disagreement may be that the time interval between the original and the re-test varied from child to child. The interval between re-tests at five years with four years could be as much as 23 months or as little as three months, and the interval between tests for three and five years could range from 35 to 13 months, although these extremes did not occur often.

An alternative explanation might be that, although children may be differentiated from each other with respect to the same dimensions at different stages in their development, individual developmental rates differ, so that relative position in the peer group is not maintained longitudinally. Should this result be confirmed with larger samples, the implication is clear that "tracking" in school should be done frequently, and children should be reassigned to homogeneous groups for greater efficiency frequently--in fact, so frequently that assignment to a "track" becomes meaningless. A child may shift from a high group to a low group, or conversely, within a year as a result of differences in developmental rates. These rates seem likely to differ from one aptitude to another, so that a large increment in one aptitude over a short time does not imply anything about changes in other aptitudes. Thus, the clear implication is that assignment to a "track" from which he may never

emerge is counter to the implications of these findings and results in a greater waste of potential. One more bit of evidence is thus added for the need for individualized instruction.

A Longitudinal Assessment of Thinking Ability of Preliterate

Children During a Two-Year Period

INTRODUCTION

Purposes and Objectives of the Overall Research Program

The present report is concerned with the fourth of a series concerned with mental functioning and its development in early childhood. This overall program involves four main objectives. First, it seemed important to obtain a realistic view of the current mental testing situation.

Second, another major purpose was to investigate the "structural" nature of preschool mentality. The first study (Stott and Ball, 1965) was made to determine what mental operations are involved in the children's responses to the currently used tests of intelligence. A series of factor analyses were presented to show the extent to which the scales showed the same or different ability-factor content, and to show the consistency of this content for each age level of these widely used mental tests.

Third, another objective was the desire to present a series of test items for preschool children which would utilize modern techniques for analyzing the data. In recent years, with the development of newer, more efficient techniques and the computer facilities for using statistical analyses, much has been learned about the structural nature of the human intellect. In the well known Guilford model (Guilford, 1967), three equally important aspects of specific ability are postulated: process or operation, content or medium of the object of thought, and the nature and form of the object or product of thinking. Each ability is describable as the confluence of one kind of process, one kind of content, and one kind of product (Hoepfner, Guilford and Merrifield, 1964; and Merrifield, in Klausmeier and Harris, 1966). In the three studies involving the preschool children with the test of thinking, differentiation was made of three kinds of process, to contrast cognition, convergent productive thinking, and divergent productive thinking. This involved focusing on the distinction between semantic (meaning of words) and figural (spatial configuration) kinds of content.

The third objective involved the need to determine more adequately whether and to what degree these various abilities have become differentiated in children at the range of preschool age levels. It was obviously necessary to obtain data derived from test items specifically designed to reveal the presence and functional level of these abilities. An important aspect of our research was then the objective of making a contribution in this area.

Fourthly, we were also much concerned with the questions of the extent to which cultural and home-environment factors influence the differential development of childhood. More and more emphasis in recent years has been given among child development researchers to the importance of adequate and appropriate stimulation in early cognitive development. The assumption is that the amount and quality of mother-child interaction is a crucial factor (Bernstein, 1960; Deutsch, 1964; Hess, 1964; Hess and Shipman, 1965). To obtain some evidence on this important question was a further purpose of the research program.

A final objective as the results of these separately developed series of research studies is to develop and standardize tests for the measurement of the various specific mental functions and abilities which characterize the different preschool age levels (ages three, four and five years).

Analysis of the Present Project

According to the findings of the completed studies of three and four-year-olds (Office of Education Nos. 6-1106 and 8-1-100), the modes of thinking can be differentiated in Caucasian children from English speaking homes between the ages of three and five. There is also suggestive evidence in these earlier findings that divergent types of ability, such as ideational fluency and originality, show little change from one age to the next. Are these tendencies maintained at the five-year-old level? Is the developmental picture of the three and four-year-old children consistent with retest findings when they are five years of age? So far, 416 children at the age of three and 426 children at the age of four have been tested. It was decided that much information could be obtained by retesting as many of these subjects as possible at the age of five years.

Since, unfortunately, the first series of tests were of four-year-old children, it was necessary to begin retesting them at once in order to gain enough retests to have any statistical value since there was only possible one year differential at the time the present study was projected. It proved to be possible to retest more of the three-year-olds since the study of children at three years followed the study of four-year-olds, and a longer time interval was possible before they became five. The problem of relocation after two years, however, was serious. This was particularly true of children in the Detroit area, since they seemed to change residences more frequently than did those in the Phoenix area.

The questions we wished to answer by this study include:

1. Do the same children tested at one or more year intervals show similar patterns of development from age to age?

2. Is it possible to appraise differentially in five-year-old children mental operations and responses similar to the ones found in the same children at ages three and four years?

3. Is there a tendency for five-year-olds to show more rapid development in convergent production than they do in divergent production as appeared to be the case in the earlier levels?

4. What relationships in development are shown by the child to the educational level of his parents, especially to his mother?

5. Does the amount of time spent by the parents with their children affect the scores on tests of their thinking ability? Do these scores differentiate convergent and divergent production?

6. How are the types of thinking affected by the environmental experience of the child?

7. Do the same factors of thinking ability occur at each of the three age levels?

GENERAL PROCEDURES

The most pressing task during this longitudinal study was to locate the children who had been tested earlier so that a retest could be done. Once a family was located, there were no objections to trying the test again to study the rate of development. The mothers were friendly and cooperative and the child was usually very pleased to be doing the "games" again.

Since many of the test items used for the three and four-year-old children were too easy for the five-year-olds, various devices were used to make them slightly more difficult. Nine of the 18 tests were changed (see Table 1). Some of the tests given to three-year-olds were eliminated and a few new ones were added, but they have not been evaluated statistically in this study. The list of tests given in Table 1 represent with a brief description the entire array of tests given to all three age levels. While the list of test items may seem long, each item required only a brief response time. The tests had interest for the children. There were no refusals at year five. The usual time taken by the test was less than one hour--often much less.

For administration, the tests were assembled in a sequence that was judged to be favorable for maintaining the child's interest. A test record booklet was provided with adequate space for recording the child's verbal responses and his performances on manipulative items, as well as significant behavior during the test.

Selection and Training of Project Personnel

A search was made for qualified individuals who were available to assist with the data collection. Some persons who had tested the three and four-year-olds were

TABLE 1.

Aptitudes and Items Included in the Statistical Study

Names of Tests

* 1. Six-cube pyramid (time, reversed). Six one inch cubes piled three cubes first row, two cubes second row, one cube on center of top.
* 2. Hidden figures. Three pictures with hidden objects--kittens, rabbits, balls--total of 16 hidden objects.
3. Stick test-matching. (Maximum score of three for five-year-olds, four for three and four-year-olds.) Matching either sticks placed in simple forms, or simple drawn figures.
* 4. Stick test-production. (Extra points for naming production.) Eight sticks placed by child in any imagined position, three trials--one point for each success.
5. Copy line, circle, cross, star, diamond. Line, circle, cross for three-year-olds and star and diamond for four and five-year-olds.
6. Drawing completion. The face, block and pie completion was used for three-year-olds; the pie and block completion for four-year-olds; and another more complex face and the pie for five-year-olds.
7. Agent action. Five questions with a supplementary question for each. "What else can you do with it?" The difficulty level was increased for five-year-olds.
8. Action agent. Six action questions, encouraging more than one answer for each question--one point credit for each answer. The six questions are changed to more difficult level for five-year olds.
* 9. Food naming. Child is asked, "Tell me all the things people like to eat." No change in form throughout for three, four and five-year olds.
10. Round things. At three years, child was shown card with eight simple drawings first and asked to select the round things. At four and five, the card was not shown. Child was asked to name all the things he could think of that were round.
11. Directions (boxes and cars test). At three and four years, placement of cars in terms of position only, then two or three discriminations were asked. At five years only, more difficult directions were given. Hence, a different number of total possible correct answers.
*12. Block sorting. Four sets of blocks--circle, square, triangle and diamond. Each set graduated in size and color--pink, blue, green and yellow. No change with age level.
*13. Little pink tower (time, reversed). Five pink blocks varying in size from 3/8" to 2". Child to reproduce a tower built of the five blocks.
14. Three-cube pyramid. Three 1-inch blocks, one to be placed on top of bottom layer of the other two. No change for three-year age span.
*15. Ambiguous forms (ideas). Three ink blots in black. Child is asked, "What is this?" and then, "What else can you see?" Answers covering the whole idea were scored as "ideas."
*16. Ambiguous forms (elaborations). These were the parts of the whole that were mentioned.
17. Word meanings. A series of ten questions. The three and four-year-olds were given an easier set of questions than the five-year-olds.
18. Two-hand thumb and finger and thumb-finger opposition. Touching all fingers in sequence with thumb was test for three and four-year-olds. Touching first two thumbs, then first two fingers, then second two fingers and the rest, each time separating preceding finger.
19. Chronological age (month within year--coded).
20. Age interval between testing (five year level only--coded).

The order of these variables is maintained throughout the study.

* Items unchanged throughout the three age levels.

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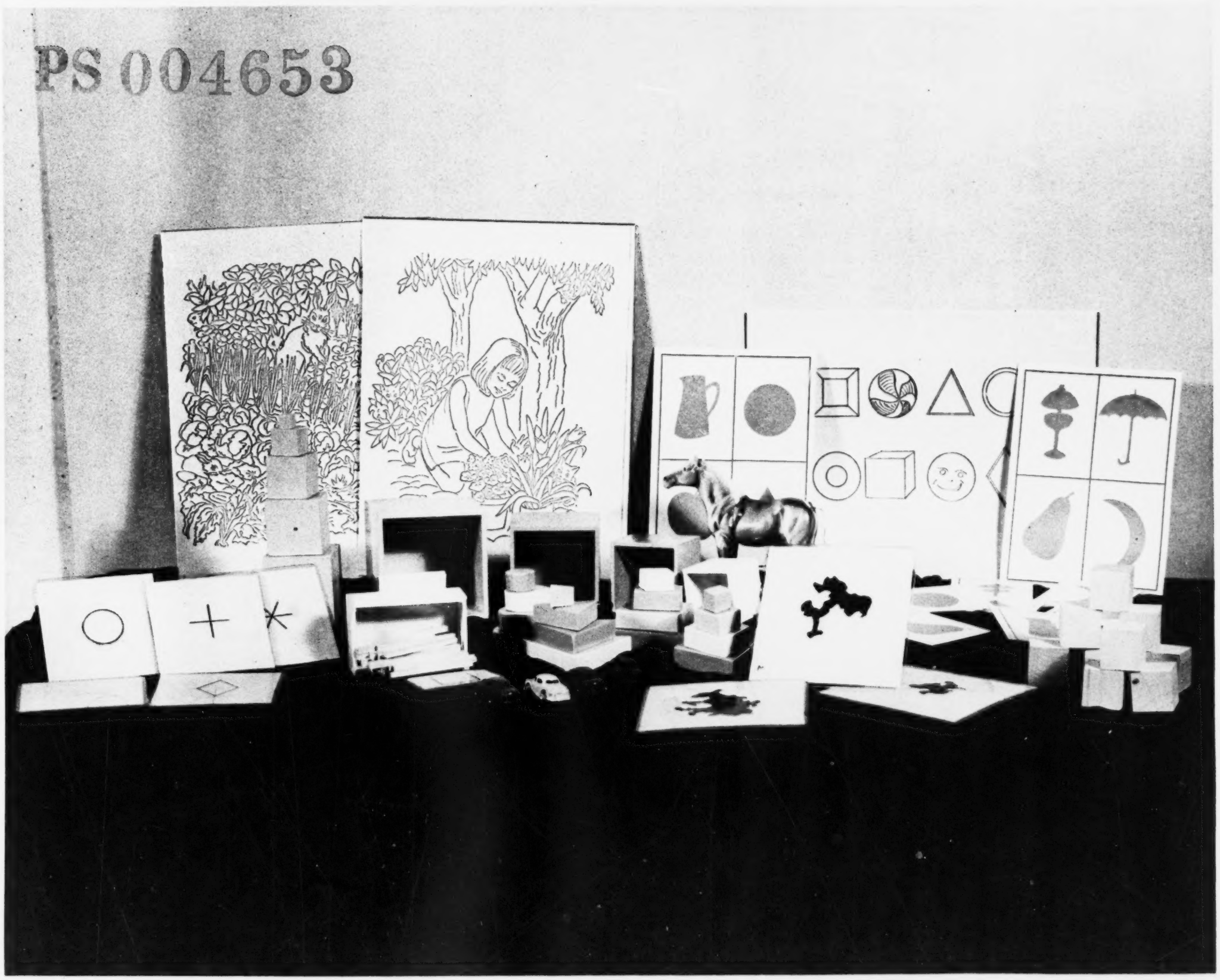

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still available, although, during the passage of time, several were no longer in the area. All of the examiners chosen had at least a master's degree in psychology. It was possible to find persons with experience with young children and ability to gain rapport with them. We were fortunate in obtaining at each center a well qualified and interested person to serve as a facilitator and coordinator who located the children who had been tested earlier and made arrangements with the mothers for the testing.

Selection of Subjects

Since our goal was to obtain as large a number as possible of children who had been tested at three or four years and who were now five, the goal of keeping the number of each educational level in a balanced control was abandoned. We retested as many children as we could find who fell within our age limits. The original selection of these children had been controlled by the education of their mothers and, in most cases, the level of the mother's education had not changed.

A description of the sample is given in Table 2. As can be seen, 147 children were included in this study. Only 16 could be located of the mothers who had ninth grade education or less, while it was relatively easy to locate the high school graduates and college educated mothers, who were apparently less mobile.

Procedures for Scoring the Test Items

Certain of the test items were timed and offered no difficulty in scoring. The tests requiring judgment of quality of performance were all scored by Rachel Ball. The data, as collected and scored, were coded. So far as possible, equivalent scores were assigned to the same task number in each age group. The tabulations were made of test performance for each child at the two matched age levels included in the study. The roster for computer treatment was coded values. Codes were prepared separately for each age group, after a comparison of frequency distributions indicated that variability within an age group would be restricted markedly if all responses were placed in the same coding system. This result is much more evident in some tasks than in others--notably those known to be related to maturation.

In order to ascertain that the requirements of the Pearson-r were met, and to provide scores in a form appropriate to later use, the coding scheme devised was to transfer each measure into the closest possible approximation of a Gaussian five-category scale. Following the area transformation procedures typically used in developing C scale or stanine scores, five categories were defined as having their limits the following cumulative proportions:

Value	Limits (cp)
1	.0000 - .0667
2	.0668 - .3084
3	.3085 - .6914
4	.6915 - .9331
5	.9332 - 1.0000

The cn varied with the age level distribution. While it was not possible to apportion the responses to correspond exactly to the frequencies for the three age levels, the rule was to assign persons to the five categories so that the overall deviation frequencies would be minimized.

ANALYSIS AND FINDINGS

The Factor Analyses

Age Five

Separate intercorrelations were made for each of the three age levels for the 18 variables plus age as the 19th variable. As noted in Table 2, for year five, only the coded age interval between testing was also included. At the bottom of the varimax table are also displayed the Guttman communalities (squared multiple correlations of each variable regressed on all other variables) which were used as the initial diagonal entry in the principal factors extraction. The intercorrelations for the 20 variables for five-year-old children (N = 147) are given in Table 3.

The values in Table 3 are fairly like those for the same variables in earlier studies as the factor solution will support, in spite of the fact that the number of children tested is only 147 and that they are five-year-olds instead of the three and four-year-olds in the earlier studies.

The chronological age was incorporated as variable 19 here to see whether it merited further analysis. Our conclusion, based on its communality of .294 and its correlations with variables 1, 9, 11, 12 and 13, is that it is of less importance at the five-year age level than at earlier ages and that none of the correlations suggests any significant regression of factor score on age, with the possible exception of the psychomotor related factor in variables 11, 12, 13 (Directions, Block Sorting, and Little Pink Tower)--even here the effect is minimal. Age differences, then, within the 5-0 to 5-11 range are relatively unrelated to performance differences, as measured by these tasks.

TABLE 2.

Description of Sample
Children of Three and Four Years Were Retested at Five Years

	No.
Chronological age at time of testing	
3 years (first test)	92
4 years (first test)	56
5 years (second test)	148
Education of mother	
Ninth grade or less	16
High school graduate	86
College graduate	45
Education of father	
Unknown or less than high school	6
High school attendance	40
College attendance	60
MA and post graduate	20
PhD, MD or higher	21
Occupation of father	
Unemployed	0
Unskilled	0
Skilled or defence forces	38
Business or student	51
Professional	58
Occupation of mother	
Part time or student	10
At home full time	103
Employed full time	34
Number of Children in Home	
1	23
2	42
3	34
4	28
5	15
6	5

	Male	Female
3 years	48	44
4 years	28	28
5 years	76	72

It is intriguing that the only significant correlation between the testing interval (V. 20) and a task is with Ambiguous Forms--Ideas (V. 15); this result would imply that children tested with a shorter time span had more ideas, so there is a slight possibility that some memory is involved, although the relationship is not strong enough to support much of an inference. (For further discussion on this variable, see page 18.)

With all the variables included, the principal factors and the first rotated varimax criterion yielded unsatisfactory results. Five factors were selected to rotate because the sum of the first five eigenvalues was approximately the same as the sum of the initial communalities and because inspection of the sixth and later principal factors indicated very little in the way of systematic covariance. In the first rotation, the first factor is very clearly verbal comprehension, and the second is clearly spatial relations. The third factor begs interpretation, seeming to be related to recency of testing and recollection of previous tasks. There is some suggestion of an imaginative component in the fourth factor, and in the fifth factor, CA appears related only to the performance (time reversed) score on the Little Pink Tower, showing some remaining influence of maturation. Hence, those variables which had low communality in this analysis were deleted as also were the age related variables.

With this adjustment, the principal factors were again obtained (omitting variables 20, 19, (CA) and the Little Pink Tower, 13, which was strongly related to it at year five). Five factors were rotated, and the results are shown in Table 4. The listings given below suggest that there are three components which are space related--NFS, NFU and NFT, and separation is somewhat clearer than in the studies of earlier ages. Variables 10 and 17 overlap the two remaining factors, but it is not unreasonable that both would involve reasoning and implications in the semantic domain.

The factors in the best five factor solution, with their significant factor loadings, follow below. Loadings of .35 or more absolute value are included.

Factor 1 - (NFS) Convergent Figural Thinking

Variable No.	Loading	Task
1	.53	Six Cube Pyramid
14	.51	Three Cube Pyramid

Hyperplane 2, 3, 5, 6, 8, 16

Factor 2 - (DMI) Originality

Variable No.	Loading	Task
16	.66	Ambiguous Forms (elaborations)
8	.59	Action Agent
7	.54	Agent Action
4	.48	Stick Test (production)
10	.44	Round Things
17	.35	Word Meanings

Hyperplane 1, 3, 6, 9, 11

Variable 10 (Round Things) and Variable 17 (Word Meanings) overlap in this factor and Factor 4. In each case, they have the smallest significant loadings, but there is an implication that, in addition to the imagination involved in each of these items, there is also implied the thinking of a meaningful object, a verbal reasoning component.

Factor 3 - (NFU) Production of Figural Units

This factor involves spatial aptitude items; the capacity to produce or perceive objects in spatial terms is clearly defined.

Variable No.	Loading	Task
5	.58	Copy Star and Diamond
6	.44	Drawing Completion
3	.40	Stick Test (matching)
1	.35	Six Cube Pyramid
15	.42	Ambiguous Forms (ideas)

Hyperplane 4, 8, 9, 14, 16

Factor 4 - (CMS) Verbal Reasoning

Variable No.	Loading	Task
11	.54	Directions (boxes and cars)
17	.45	Word Meanings
10	.42	Round Things
9	.38	Food Naming

Of course all of these items also involve memory, but so do most of the other variables require some degree of memory facility. The most discriminating quality of the high loadings present in this factor is the ability to form meaningful verbal associations.

TABLE 3.

Intercorrelation Matrix

Five-Year-Old Aptitudes

Aptitudes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1.000	.197	.202	- .132	.288	.353	.208	.135	.234	.266	.161	.210	.119	.362	- .021	- .050	.061	.004	.208	.132
2	.197	1.000	.200	- .029	.123	.259	.182	.217	.064	.258	.253	- .026	.038	- .011	.160	.123	.085	.057	.187	.052
3	.202	.200	1.000	- .053	.329	.213	.139	.091	.133	.167	.266	.038	.070	.074	.028	.019	.163	.151	.055	.023
4	- .132	- .029	- .053	1.000	.119	- .049	.142	.339	- .047	.014	- .154	.026	.000	- .082	.077	.328	.107	.213	.037	.031
5	.288	.123	.329	.119	1.000	.290	.189	.148	.013	.181	.081	- .162	.165	.078	.147	.101	.266	.196	.165	.076
6	.353	.259	.213	- .049	.290	1.000	.103	.140	.149	.169	.181	- .116	.012	- .032	.155	.101	.126	.194	- .069	.014
7	.208	.182	.139	.142	.189	.103	1.000	.464	.219	.429	.157	.035	.000	.182	.081	.373	.365	.040	.096	.028
8	.135	.217	.091	.339	.148	.140	.464	1.000	.215	.422	.223	.012	.039	.104	.191	.361	.304	.149	.133	.007
9	.234	.064	.133	- .047	.013	.144	.219	.215	1.000	.196	.247	.050	.196	.173	.027	- .090	.218	.004	.220	.147
10	.266	.258	.167	.014	.181	.169	.429	.422	.196	1.000	.335	.011	- .075	.224	.151	.362	.405	.107	- .017	- .028
11	.161	.253	.266	- .154	.081	.181	.157	.223	.247	.335	1.000	.117	.118	.107	.075	- .073	.268	.105	.176	- .015
12	.210	- .026	.038	.026	- .162	- .116	.035	.012	.050	.011	.117	1.000	- .007	.059	.041	.034	.026	.020	.173	.189
13	.119	- .038	.070	.000	.165	.012	.000	.034	.196	- .075	.118	- .007	1.000	.104	.124	- .131	- .082	.095	.171	.101
14	.362	- .011	.074	- .082	.078	- .032	.182	.104	.173	.224	.107	.059	.104	1.000	- .021	- .054	.230	- .011	.131	.032
15	- .021	.160	- .028	.077	.147	.155	.081	.191	.027	.151	.075	- .041	.124	- .021	1.000	- .019	.130	- .021	.037	- .246
16	- .050	.123	.019	.328	.101	.101	.373	.361	- .090	.362	- .073	.034	- .131	- .054	- .019	1.000	.210	.230	- .115	- .007
17	.061	.085	.163	.107	.266	.126	.365	.304	.218	.405	.268	.026	- .082	.230	.130	.210	1.000	.125	.053	- .059
18	.004	.057	.151	.213	.196	.194	.040	.149	.004	.107	.105	.020	.095	- .011	- .021	.230	.125	1.000	- .005	.056
19	.208	.187	.055	.037	.165	- .064	.096	.133	.220	- .017	.176	.173	.171	.131	.037	- .115	.053	- .005	1.000	.335
20	.132	.052	.023	.031	.076	- .014	.028	.007	.147	- .028	.015	.189	.101	.032	- .246	- .007	- .059	.056	.335	1.000
Guttman Communalities	.464	.232	.217	.284	.379	.341	.372	.420	.256	.463	.332	.225	.179	.248	.228	.410	.351	.174	.294	.233

TABLE 4.

Varimax Rotation Analysis

Five-Year-Old Children

N = 147

$A_{.05} \geq .316$

Rotated Factor Loadings

	1	2	3	4	5
1	.528	-.014	.345	.075	.284
2	-.042	.120	.194	.185	.419
3	.086	-.007	.402	.196	.140
4	-.180	.484	.061	-.123	-.181
5	.078	.169	.584	.042	.015
6	.039	.043	.436	.069	.366
7	.228	.535	.100	.274	.103
8	.033	.594	.093	.306	.135
9	.243	.019	.060	.380	.068
10	.221	.441	.105	.417	.259
11	.057	-.036	.134	.535	.245
14	.508	.041	.052	.207	-.089
15	-.186	.113	.167	.179	.074
16	-.051	.662	.006	-.082	.115
17	.114	.347	.219	.445	-.107

Factor 5 - (NFT) Figural Redefinition

This is a new factor name in our classification of test variables and seems justified by the nature of the content which involves finding hidden animals or other objects in a complex scene, or drawing missing elements in incompleted drawings (a small but significant loading indicates this component in test item 6, Drawing Completion, although it is much more highly loaded in Factor 3, involving the production of the missing parts in the incomplete figures).

Variable No.	Loading	Task
2	.42	Hidden Figures
6	.37	Drawing Completion

An oblique solution to the rotation of the principal factors, the promax procedure used the initial varimax solution as a target for an oblique solution which might have a better fit. However, the cosine matrix showed quite clearly that the five factors are nearly orthogonal and the content of the rotated factors is nearly the same as for the orthogonal solution presented above.

Age Four

Although 55 is a small sample for determining the relationships at the four-year-old level, the procedure of analysis parallels for age four the processes shown for five-year-olds. The correlations in Table 6 show a few variations in factor content from previous four-year-old results, but nothing too remarkable. The four-year-old factors obtained from the varimax rotation are quite similar to previous results, notwithstanding the very small sample, both to previous four-year-olds and the present five-year-olds. Thus, the sampling of these children from the larger group on which the previously reported four-year-old results were based seems to have been reasonably unbiased, at least with respect to the underlying factor structure. The intercorrelations and the varimax rotation are presented in Tables 6 and 7.

The specific interpretations for the varimax rotation are presented here in addition to the tabular varimax rotation. The order of factors is not the same as in the previous study of the larger sample of four-year-olds, but the same factors are duplicated with the absence of a psychomotor control factor which includes two variables, only one of which is present in this analysis: Thumb-Finger Opposition and Fist and Thumb (not included).

Since chronological age is included in the variables and was not present in the earlier study, the item Thumb-Finger Opposition intrudes itself into two factors, perhaps indicating that these two factors are, to some extent, maturational in nature. In

most of these factors, there is a confusion of factor meaning which might have been resolved if a hand rotation procedure had been applied. However, because of the small sample, this was not considered worthwhile. The factor loadings are significant for year four only to .50; however, other large loadings are included.

Factor 1 - (DMU) Ideational Fluency

Variable No.	Loading	Task
4	.58	Stick Test (production)
19	.55	Chronological Age
2	.53	Hidden Figures
18	.45	Thumb and Finger Opposition
16	.39	Ambiguous Forms (elaborations)

Item 2 (Hidden Figures) has consistently fallen into NFT (figural redefinition). It is plain to see the mixed character of this Factor 1. However, the Ambiguous Forms (elaborations) seems consistent with the highest loading available, Stick Test (production).

Factor 2 - (NFU) Production of Figural Units

Variable No.	Loading	Task
13	.68	Little Pink Tower
3	.65	Stick Test (matching)
6	.40	Drawing Completion
12	.37	Block Sorting

Spatial thinking is involved in all of these variables where form and size are important in the response required.

Factor 3 - (CMS) Verbal Reasoning

Variable No.	Loading	Task
7	.71	Agent Action
8	.61	Action Agent
11	.42	Directions (boxes and cars)
17	.40	Word Meanings

While Action Agent and Agent Action variables often fall in DMI (originality), since extra points were added for elaborations in later test scoring, the earlier scoring of these two tests did not include these additions and, consequently, they do not load on Factor 4 in this varimax rotation.

TABLE 6.

Intercorrelation Matrix

Four-Year-Old Aptitudes

Aptitudes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1.000	.134	.202	.213	.166	.070	.026	- .134	.003	.268	.180	.069	.147	.262	.028	.212	.178	- .035	- .143
2	.134	1.000	- .002	.239	.109	- .044	.043	- .031	.178	.379	.182	.029	.083	.198	.012	.198	.111	.219	.377
3	.202	- .002	1.000	.144	.249	.384	- .026	.103	.039	.113	.167	.302	.471	.185	- .026	- .007	.034	- .036	- .069
4	.213	.234	.144	1.000	.000	.059	.006	- .095	.139	.189	- .003	- .014	- .041	.291	.206	.305	.163	.254	.326
5	.166	.109	.249	.000	1.000	.111	- .164	.042	- .153	.251	.022	.201	.106	.254	- .113	- .086	.006	.025	.004
6	.070	- .044	.384	.059	.111	1.000	.032	.217	.070	.108	- .062	.043	.213	.100	.213	.037	.149	- .154	- .041
7	.026	.043	- .026	.006	- .164	.032	1.000	.415	.168	.245	.271	- .105	.016	.219	.133	.089	.401	.104	.021
8	- .134	- .031	.103	- .095	.042	.217	.415	1.000	.043	.087	.214	.270	.149	.147	.039	- .237	.133	.130	.040
9	.003	.178	.039	.139	- .153	.070	.168	.043	1.000	.099	.248	.147	.214	.169	.012	.133	.114	.024	- .076
10	.268	.379	.113	.189	.251	.108	.245	.087	.099	1.000	.217	- .013	- .028	.206	.281	.111	.231	- .043	.099
11	.180	.182	.167	- .003	.022	- .062	.271	.214	.248	.217	1.000	- .030	.181	- .036	.010	- .014	.133	.069	- .027
12	.069	.029	.302	- .014	.201	.043	- .105	.270	.147	- .013	- .030	1.000	.193	- .001	- .195	- .240	- .078	.052	- .196
13	.147	.083	.471	- .041	.106	.213	.016	.149	.214	- .028	.181	.193	1.000	.224	.182	.108	- .022	- .090	- .189
14	.262	.198	.185	.291	.254	.100	.219	.147	.169	.206	- .036	- .001	.224	1.000	.042	.180	.163	.221	- .066
15	.028	.012	- .126	.206	- .113	.213	.133	.039	.012	.281	.010	- .195	.182	.042	1.000	.216	.060	- .310	.002
16	.212	.198	- .007	.305	- .086	.037	.089	- .237	.133	.111	- .014	- .240	.108	.108	.216	1.000	.121	.007	.188
17	.178	.111	.034	.163	.006	.149	.401	.133	.114	.231	.133	- .078	- .022	.163	.060	.121	1.000	- .108	.033
18	- .035	.219	- .036	.254	.025	- .154	.104	.130	.024	- .043	.069	.052	- .090	.221	- .310	.007	- .108	1.000	.249
19	- .143	.377	- .069	.326	.004	- .041	.021	.040	.076	.099	- .027	- .196	- .189	.066	.002	.188	.033	.249	1.000
Guttman Communalities	.298	.404	.491	.435	.327	.322	.496	.491	.316	.424	.375	.431	.452	.448	.414	.289	.284	.365	.434

TABLE 7.

Varimax Rotation Analysis

Aptitudes, Four-Year-Olds

N = 55

Rotated Factor Loadings

	1	2	3	4	5
1	.104	.180	.001	.139	.463
2	.532	-.024	.124	-.027	.251
3	.006	.647	.013	-.106	.250
4	.580	.089	-.029	.171	.179
5	-.033	.135	-.079	-.248	.525
6	-.093	.404	.110	.172	.122
7	.060	-.058	.705	.139	-.012
8	-.108	.171	.612	-.267	-.061
9	.290	.259	.248	.056	-.157
10	.169	-.022	.315	.197	.525
11	.083	.122	.420	-.026	.066
12	-.099	.373	.028	-.462	.090
13	.002	.679	.078	.051	.013
14	.297	.239	.187	-.005	.355
15	-.011	.134	.119	.589	.037
16	.392	.060	-.063	.418	.062
17	.063	-.023	.398	.226	.211
18	.454	-.113	.088	-.412	-.034
19	.552	-.222	.028	-.006	-.069

Factor 4 - (DMI) Originality

Variable No.	Loading	Task
15	.59	Ambiguous Forms (ideas)
12	-.46	Block Sorting
16	.42	Ambiguous Forms (elaborations)
18	-.41	Thumb and Finger Opposition

The first and third variables are definitely classifiable as DMI, but the Thumb anf Finger Opposition and Block Sorting do not involve originality and show negative loadings, perhaps having a maturational significance, and may imply some lack of age relationship with the two positive factors.

Block Sorting and Thumb and Finger Opposition are spatial, while the two Ambiguous Forms measures are really more semantic. This separation of semantic and figural is not at all uncommon. In these data, there is no further principal factor which could be used to separate them. A graphic rotation of Factor 4 against Factor 1 would clearly separate V. 18 and V. 16 on nearly orthogonal factors, but the other variables on the two factors would be located in the space between them. This latter solution would be less appropriate in terms of both structure and interpretation.

Factor 5 - (NFS) Convergent Figural Thinking

Variable No.	Loading	Task
5	.53	Copy Star and Diamond
10	.53	Round Things
1	.46	Six Cube Pyramid
14	.36	Three Cube Pyramid

Note that, at year five, the Three and Six Cube Pyramid variables had the only high loadings for NFS (convergent figural thinking). Certainly Round Things and Copy Star and Diamond involve figural spatial thinking, although they have loaded on other factors in year five.

Age Three

Since there were 92 children at this age level, it was considered desirable to hand rotate some of the factors at the three-year-old level. Table 8 gives the intercorrelations obtained for three-year-olds, and the varimax rotation with the hand rotated factors included are given in Table 9. The loadings for this factor analysis were significant at the .35 level.

Factor 1 - (DMU) Ideational Fluency

Variable No.	Loading	Task
17	.62	Word Meaning
7	.58	Agent Action
9	.48	Food Naming

These three variables are obviously correctly placed, since, at the year three, the scoring for Agent Action included the elaborations not included in the four year scoring, and the other two variables are conspicuously verbal fluency.

Factor 2 - (DFS) Visual Reasoning

Variable No.	Loading	Task
4	.52	Stick Test (production)
12	.40	Block Sorting
8	.34	Action Agent

While Block Sorting was selected for a test of flexibility in the roster of test items, it shows a slightly significant loading in what we chose to label originality, since that is the major significance of Stick Test (production). It might be expected that Action Agent would have a higher loading, but the score for this depends upon the number of correct answers given to the five questions and the three-year-olds may have shown less tendency to give more than one answer to each question; hence, to show less originality.

Factor 3 - (NFS) Convergent Figural Thinking

Variable No.	Loading	Task
5	.62	Copy Line, Circle, Cross
1	.57	Six Cube Pyramid
6	.54	Drawing Completion
3	.48	Stick Test (matching)
18	.40	Thumb-Finger Opposition
7	.34	Agent Action
19	.34	Chronological Age

It would seem likely that this factor should not include the loadings under .48, as even the Thumb-Finger Opposition does not seem so related to the first four items. The higher loaded variables are easily seen to belong to the NFS factor.

Factor 4 - (CMS) Verbal Reasoning

Variable No.	Loading	Task
16	.53	Ambiguous Forms (elaborations)
11	.45	Directions (boxes and cars)
3	.35	Stick Test (matching)
13	.34	Little Pink Tower

One might question why Ambiguous Forms (elaborations) would fall under the factor of visual reasoning and at so high a loading. However, if one realizes the process which the child goes through in performing this test, it can be justified as visual reasoning. The child sees the ink blot and makes a judgment of the whole object, perhaps saying "a cow," which is scored as one point for Ambiguous Forms (ideas). Then he is asked, "What else do you see?" and he answers, "It has legs and a tail," which is scored two points for elaboration--a rational visual judgment in connection with his previous decision that it is a cow.

Factor 5 - (NFU) Production of Figural Units

Variable No.	Loading	Task
2	.58	Hidden Figures
15	.54	Ambiguous Forms (ideas)
8	.49	Action Agent
19	.40	Chronological Age

While these factors are somewhat more consistent than the ones at the four-year-old level, they are still less meaningful than the factors for the five-year-olds. The hand rotation lent some consistency to the factors which was not there before the varimax rotated results. Apparently the smaller numbers for the two younger ages tend to affect the consistency of the rotations.

There are several possible reasons for the divergence which occurs between the earlier studies of three and four-year-olds and the present five-year-old group of 147 children. Of course, the smaller sample is one possible explanation, but, also, there was a variation in examiners, and a variation in testing conditions. Furthermore, many of the children had moved and could not be located; hence, the sample chosen is a more stable one than the first, and the percent of children in the categories of mothers who were ninth grade, high school graduates, and college graduates was not consistent with the earlier studies, and some evidence is shown that the mother's educational level is of importance.

After the appropriate factor structures were established for each age level, the plan was to intercorrelate the factor loadings for the variables on the four and five-year

TABLE 8.

Intercorrelation Matrix

Three-Year-Old Aptitudes

Aptitudes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	1.000	.118	.222	- .072	.476	.271	.286	.137	.336	.172	.165	.213	.256	.272	.063	- .041	.188	.248	.068
2	.118	1.000	.183	.021	.292	.155	.308	.371	.260	.293	.053	.285	.137	.174	.350	.229	.111	.186	.215
3	.222	.183	1.000	.157	.307	.370	.216	.165	.050	.173	.330	.150	.302	.108	.141	.097	.048	.247	.126
4	- .072	.021	.157	1.000	- .006	.087	.185	.250	.084	- .068	- .044	.329	- .084	.091	.190	.111	.023	.008	.094
5	.476	.292	.307	- .006	1.000	.292	.346	.333	.354	.435	.278	.162	.205	.176	.140	- .095	.261	.269	.288
6	.271	.155	.370	.087	.292	1.000	.243	.165	.106	.227	.185	.226	.067	.188	.004	.014	- .029	.241	.261
7	.286	.308	.216	.185	.346	.243	1.000	.466	.447	.273	.179	.463	.123	.106	.330	.131	.547	.305	.247
8	.137	.371	.165	.250	.333	.165	.466	1.000	.312	.008	.165	.316	.021	.096	.386	.091	.304	.092	.340
9	.336	.260	.050	.084	.354	.106	.447	.312	1.000	.295	.088	.292	.141	.023	.204	- .033	.237	.296	.163
10	.172	.293	.173	- .068	.435	.227	.273	.008	.295	1.000	.143	.173	.132	.017	.156	.070	.277	.324	.139
11	.165	.053	.330	- .044	.278	.185	.179	.165	.088	.143	1.000	.065	.201	.018	.040	.263	.206	.233	.212
12	.213	.285	.150	.329	.162	.226	.463	.316	.292	.173	.065	1.000	.111	.239	.235	.017	.293	.232	.183
13	.256	.137	.302	- .084	.205	.067	.123	.021	.141	.132	.201	.111	1.000	.112	.006	.201	.176	.256	.182
14	.272	.174	.108	.091	.176	.188	.106	.096	.023	.017	.018	.239	.112	1.000	.202	- .072	.009	.081	.296
15	.063	.350	.141	.190	.140	.004	.330	.386	.204	.156	.040	.235	.006	.202	1.000	.106	.202	.061	.266
16	- .041	.229	.097	.111	- .095	.014	.131	.091	- .033	.070	.263	.017	.201	- .072	.106	1.000	.111	.143	.014
17	.188	.111	.048	.023	.261	- .029	.547	.304	.237	.277	.206	.293	.176	.009	.202	.111	1.000	.187	.150
18	.248	.186	.247	.008	.269	.241	.305	.092	.296	.324	.233	.232	.256	.081	.061	.143	.187	1.000	.239
19	.068	.215	.126	.094	.288	.261	.247	.340	.163	.139	.212	.183	.182	.296	.266	.014	.150	.239	1.000
Guttman Communalities																			
	.398	.374	.354	.263	.517	.328	.552	.469	.366	.395	.283	.379	.263	.247	.303	.278	.423	.275	.322

TABLE 9.

Varimax Rotation Analysis

Three-Year-Old Aptitudes

Rotated Factor Loadings

	1	2	3	4	5
1	.21	-.076	.57	-.06	.051
2	.13	-.031	.19	.10	.578
3	-.09	.125	.48	.35	.076
4	-.01	.519	.03	-.01	.141
5	.25	-.196	.62	-.02	.220
6	-.10	.105	.54	.08	.070
7	.58	.299	.34	.07	.278
8	.24	.344	.21	-.02	.493
9	.48	-.005	.27	-.09	.202
10	.33	-.298	.32	.13	.208
11	.09	-.003	.29	.45	.040
12	.29	.404	.32	-.06	.213
13	.09	.096	.30	.34	.019
14	-.06	.119	.08	-.04	.212
15	.15	.190	.06	-.02	.535
16	-.08	.087	-.10	.53	.179
17	.62	.106	.12	.14	.120
18	.22	.151	.40	.25	.082
19	-.01	.094	.34	.05	.395

Factors 1, 3 and 4 are hand rotated.

TABLE 10.

Intercorrelation Matrix

Aptitudes at Five Years and Four Years

Five Year Aptitudes

Four Year Aptitudes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	.003	- .028	- .146	.075	.258	.177	1.50	.057	- .066	.281	- .005	- .141	.117	- .014	.193	.286	.326
2	- .079	.070	- .177	.119	.126	- .146	.180	.095	- .112	.168	- .080	- .042	.062	.067	.016	.156	- .040
3	- .033	- .103	- .009	.182	.399	.061	- .072	- .034	- .289	- .142	.029	- .188	.164	.127	- .126	- .024	.109
4	- .213	- .127	- .188	.104	.047	- .020	.060	.013	- .117	- .040	.030	- .081	.074	- .052	.113	- .100	.116
5	- .064	.259	.118	.132	.171	.350	- .027	- .122	.000	- .075	.034	- .025	.183	- .034	- .049	- .022	- .023
6	- .010	- .040	- .016	.063	.099	.114	- .067	- .003	- .198	- .008	.054	- .134	- .034	- .122	.175	.084	- .075
7	.089	.050	- .151	.096	.077	- .115	- .103	.319	.100	.101	.148	.010	- .019	.021	.106	.156	.239
8	- .061	- .149	.180	.248	- .004	- .167	- .217	.118	.294	- .171	.265	.085	.052	- .118	.030	- .279	- .142
9	.047	- .051	- .283	.036	- .003	- .042	.071	.151	.053	.118	.034	- .097	.164	.096	.130	- .077	- .183
10	- .057	.101	- .120	.080	.014	- .070	.253	.180	.091	.213	- .007	.161	.214	.039	.135	.275	.143
11	- .028	- .173	- .155	.164	.032	- .207	.071	- .003	.000	- .146	- .085	.009	.273	.220	- .151	.063	- .118
12	- .089	- .037	.044	- .014	.047	- .222	- .093	.010	.163	- .022	.181	.221	.285	- .232	- .314	- .143	- .128
13	.287	- .036	.001	.035	.353	.232	- .083	- .135	- .097	- .061	- .077	- .164	.272	.125	- .069	- .141	.083
14	.077	- .043	.036	.016	.243	- .020	- .064	.003	- .092	- .049	- .014	.059	.096	.038	.015	.029	.055
15	- .004	- .097	.004	.174	.021	.092	.227	.088	.061	.197	.142	.030	.150	- .015	.237	.214	.325
16	- .079	- .025	- .161	- .136	.165	- .104	.176	.011	- .015	.198	.085	- .019	.005	.108	.106	.198	.299
17	- .093	.213	- .194	.264	.041	.078	- .073	.294	.063	.047	- .047	- .154	- .049	- .164	.106	.258	.026

TABLE 11.

Intercorrelation Matrix

Aptitudes at Five Years and Three Years

Five Year Aptitudes

Three Year Aptitudes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	.283	.197	.271	.112	.247	.349	.129	.126	.201	.174	.074	.077	.156	.008	.131	.001	.144
2	.003	.080	.004	.072	.007	- .059	.030	.005	- .078	- .009	- .088	- .136	- .045	.041	.032	.232	- .037
3	.289	- .020	.218	- .066	.322	.305	.037	.103	.054	.086	.175	- .138	.031	.046	.038	.061	.092
4	.137	.101	.092	- .166	- .019	.046	- .122	- .035	- .168	- .159	.004	- .061	.033	- .092	- .137	.009	- .269
5	.351	.043	.258	.148	.326	.311	.266	.129	.167	.231	.235	- .106	.055	.021	.099	.090	.121
6	.361	.263	.388	- .075	.270	.338	.136	.206	.213	.132	.263	.001	.174	.251	.117	.001	.118
7	.229	.008	.201	- .008	- .006	.200	.293	.202	.280	.024	.069	- .054	.006	- .048	.010	.056	.097
8	.151	.058	.180	.070	.032	.115	.179	.340	- .023	.136	- .047	- .144	- .092	- .028	.119	.214	.072
9	.108	.066	.054	- .089	.008	.110	.217	.015	.242	.129	- .062	- .058	.021	- .081	.122	.097	.154
10	.100	.027	.209	- .010	.103	.205	.267	- .028	.191	.194	.259	.026	- .093	.005	.002	.037	.164
11	.124	- .025	.244	- .109	.151	.142	- .045	- .007	.109	.103	.190	- .192	- .083	.043	.108	- .247	.167
12	.271	.295	.154	- .070	.219	.195	.134	- .001	- .024	.026	.015	.009	.021	- .027	- .065	- .006	.027
13	- .012	.126	.053	.024	.224	.228	.005	- .135	.128	- .055	.079	- .331	- .051	- .191	- .071	- .027	.001
14	.136	.146	.031	- .044	.156	.071	.064	- .004	.030	- .143	- .004	.024	- .002	.072	.072	.158	- .055
15	.032	.021	.069	- .040	- .117	.025	.123	.058	- .013	.126	.022	- .094	- .191	.045	- .084	.227	- .008
16	.001	.033	- .001	- .061	- .083	.225	.043	- .023	- .036	- .186	.000	- .094	.031	.026	- .024	.030	- .121
17	- .031	.009	.157	.047	- .104	- .023	.306	.107	.174	.060	.149	- .050	.021	- .089	- .050	- .020	.120

factors and the three and five-year factors. These intercorrelations are presented in Table 10 and Table 11. As can be seen from inspection, these intercorrelations are small, the highest for four with five years is .40 for Item 3, Stick Test (matching), with Item 5, Copying Star and Diamond. There are no high intercorrelations with the same variables at the two age levels, the highest being .27.

The intercorrelations of three and five-year factor loadings for the aptitudes yielded some variables which had fair correlations at the two age levels, such as variable 5 = .33, Copying Line, Circle, Cross at three years with Copying Star and Diamond at five years. The highest value for this matrix was .39, Variable 3, Stick Test (matching), with Variable 6, Drawing Completion. The two Drawing Completion variables at ages three and five had a value of .34.

Computation of factor scores was considered for all three ages, but the number of cases was minimal for this approach, so the standard errors of factor loadings, and thus the factor scores at three and four years would be quite large. Accordingly, it was decided to obtain factor scores at age five to compare with questionnaire responses and to see to what degree the test scores at age three, or four, predicted the factor scores at age five. This final step requires a canonical correlation, which the inter-correlation of aptitudes at age three and age five, and age four and age five, suggest that no great hope should be held out for a high level of prediction.

Canonical Correlation Analysis

A canonical correlation analysis was made and, for it, the results are a little more rewarding. The canonical correlation begins with a correlation matrix subdivided into A, the intercorrelations among predictors (in this case, test scores at age three); B, the intercorrelations of several criteria (in this case, the given factor scores at age 5); and C, the intercorrelations of each predictor (age three test) with each criterion (age five factors). The statistical procedure finds a composite in A and composite in B in such a way that the correlation between the two composites (based, of course, on the correlations in Section C) are as high as possible.

These two composites are then called a canonical vector. As in factor analysis, after the first canonical vector is extracted, residual correlations are computed and the second canonical vector is obtained, etc., until the correlations are accounted for. In this case, because the criteria were pretty much uncorrelated and the predictors had a similar underlying structure, we had five canonical vectors. These were hand rotated to make each one as nearly unique for a factor score (our criterion variables) as possible. The angle of rotation was based on the relations among the factor scores as they loaded in the canonical vectors, and the same transformation (orthogonal) was applied to the tests loading these vectors.

To summarize the results:

Factor NFS at age five is best predicted by Test 13, Little Pink Tower, at age three.

Factor DMI at age five is best predicted by Test 8, Action Agent, at age three. There is some indication of a negative weighting of Directions at age three on this factor.

Factor NFU, age five, is best predicted from Test 5, Copy Line, etc., age five, and secondarily by Test 3, Stick Test (matching). There is a hint of a negative loading of Test 17, Word Meaning, on this factor.

Factor CMS, age five, is best predicted by Test 11, Directions, and Test 17, Word Meanings, at age three.

Factor NFT, age five, is best predicted by Test 6, Drawing Completion, and by Test 18, Thumb-Finger Opposition, at age three.

The negative relations obtained support the idea of differential rates of development for the different factors, rather than being interpreted as in any way inhibiting development. This further corroborates the findings discussed earlier concerning these varying rates of development.

One curious finding, probably attributable to the constraints of the sampling process, is that children who were tested when they were "older threes" tend to have better factor scores at age five on NFS and CMS than did children tested as "younger threes."

TABLE 12.

Questionnaire Items

1. Marital status: married, other.
2. Sex.
3. Phoenix or Detroit.
4. Education of mother: ninth grade or less, high school graduate, college graduate.
5. Education of father: unknown or less than high school, high school attendance, college attendance, MA and postgraduate, PhD, MD or higher.
6. Occupation of father: unemployed, unskilled, skilled or defense forces, business or student, professional, part time employed.
7. Occupation of mother: part time or student, at home full time, employed full time.
8. Number of children in the home.
9. Kind of TV programs watched: children's only, other.
10. Father reads to child: never, sometimes, often.
11. Mother reads to child: never, sometimes, often.
12. Father plays with child: never, some every day, weekends.
13. Mother plays with child: never, some every day, weekends.
14. Nursery school: attended, did not attend.
15. Kindergarten: attends, does not attend.
17. Number of traits named as causing parental anxiety.
20. Did mother pick up baby when it was crying?

Only the items included in the statistical treatment are given here.

The Questionnaire

The questionnaire items for the five-year-olds which were coded to a normalized five-point scale are shown in Table 12. Ten of the items in the questionnaire had spotty responses (many blanks) and so were not included in this analysis. Inspection of the distribution of responses indicated that more information could be extracted from a correlational approach than from a contingency analysis or analysis of variance, so the questionnaire relations to aptitudes for five-year-olds are given in correlational terms (Table 13). For this table, the factor scores for the five-year-old children were computed (the only place where these factor scores were used).

Questionnaire Factor 1 includes variables Q4, Q5 and Q6. Clearly their concurrence suggests a socioeconomic basis, coupled with intelligence or at least persistence in completing school. This group of items related positively to Aptitude Factor 4, verbal reasoning, with a hint of positive relationship to Aptitude Factor 3, spatial aptitudes.

Questionnaire Factor 2 includes area and sex and seems vaguely related to the sampling design. The relation of this factor to Aptitude Factors DMI (originality) and CMS (verbal reasoning) seems to be slightly negative.

Questionnaire Factor 3 involves Questionnaire Items 10 and 11, whether the parents read to child, while the loading for Q20, pick up child when he cries, and Q17, number of traits causing parental anxiety, are possibly related slightly. A wild name for this factor might be "achievement-oriented, slightly apprehensive parental attitude." Interestingly, this parental attitude is related positively to the two aptitude factors dealing with space, Factor 1, for construction and Factor 5 for transformation, but hardly at all to either semantic factor, so that reading to the child does not seem related to tasks involving verbal production. The reading for a child of five or younger probably involves a great deal of exploration of pictures accompanying the text, so that the spatial, visual aspects of the experience of having someone read stories are emphasized more than the verbal.

Questionnaire Factor 4 is an interesting constellation of father playing with the child, married parents, and several children in the home, but no nursery school attendance. It might be called "family-centered home," but it is unrelated to any aptitude factor.

Questionnaire Factor 5 draws on mother's playing with the child (weekends more than daily), kindergarten attendance, the child listening to adult programs on TV, and full time occupation of the mother. It seems to reflect "working, single mother" and "few siblings," but it is unrelated to aptitude factors except that Item Q7, full time working mother, seems negatively related to Aptitude Factor 4, CMS (verbal reasoning).

A few individual questionnaire items have interesting relations with factor scores:

Factor 1 - (NFS) Convergent Figural Thinking

1. Girls do less well on this than boys--a result that is usually found.

2. Children whose fathers read to them show more aptitude in this kind of thinking.

Factor 2 - (DMI) Originality

1. Phoenix children tend to score higher than those in Michigan.

2. Children scoring high on this factor tend to have more traits causing parental anxiety.

3. Children who have few or no siblings tend to score higher on this originality factor. One might speculate that parents having fewer children and, thus, more time to spend with each may have more interaction with the child, may show more concern about his personality development and may induce more fluent or imaginative responses from the child. However, since the r is of small size, this conclusion may be extremely speculative.

Factor 3 - (NFU) Production of Figural Units

1. The more highly educated mothers have children who tend to score higher on this factor, a spatial construction ability. Also, children who attend kindergarten have higher scores.

Factor 4 - (CMS) Verbal Reasoning

1. The Detroit children tend to score somewhat lower on this factor.

2. Children of working mothers tend to have lower scores.

3. It is interesting that Q20, picking up the crying baby "when he needed it," is positively related, though probably not significantly, to CMS, verbal reasoning. Is it possible that systematic, purposive response to verbalization speeds the development of language?

Factor 5 - (NFT) Figural Redefinition

1. The Detroit children tend to score lower also on this transformation test.

Other observations about the questionnaire:

1. The working mother syndrome in the questionnaire consists of this combination: mother works full time, plays with the child weekends, sends child to kindergarten and child tends to watch other than children's TV programs. This composite group of related items is slightly negatively related to verbal reasoning. Or, stated another way, mothers who are employed full time have children who do less well on verbal reasoning.

2. There is a slight indication that children whose fathers read to them more often are able to do better on convergent figural tasks.

3. Perhaps the fact that there is a small positive relation between aptitudes in DMI and the number of traits causing parental anxiety may indicate that the parents who are more attentive to their children's personality tendencies have children who are more imaginative and more fluent.

4. The education of the mother is much more important in the aptitudes in Factor 3, spatial construction, than is the education of the father or his occupation.

Three items which were selected to indicate the changes between the ages of three to five years are analyzed in Figures 1, 2 and 3.

Changes in performance on Hidden Figures, a representative of Aptitude Factor 5, figural redefinition, are clearly age-related, with a greater increment between four and five years than between three and four. Unfortunately, there is a ceiling on the test, with 26 percent of the five-year-olds tested achieving the maximum score. A test of embedded geometric figures was administered to the five-year-olds and will be analyzed later. The findings on Ambiguous Forms (ideas), representing originality, are rather different. Here there seem to be no differences in performances by the three age groups. In contrast, age differences again appear in performances on Ambiguous Forms (elaborations). While it is possible that these differences reflect mostly an increase in fluency, perhaps based on more vocabulary due just to acculteration, it is intriguing that the changes are in the ability to focus on parts of the total form rather than to provide labels for the whole.

In comparing change scores of Ambiguous Forms (elaborations) with the education of the mother, the probability was just greater than .05, but less than .10, so it is marginally significant that children whose mothers have higher education also score higher on this test.

There was no significant relation of performances on these three tests with whether either the mother or father played with the child. However, the three to five-year change in performance on Hidden Figures is related to three other questionnaire variables. Parents who read to their children have children whose gains are less

than those of children not read to (r = -.27). Very likely, this result is a combination of the previously reported positive relation between being read to and performance that the factor Hidden Figures represents and the ceiling effect noted just above. No relation was found with either of these three tests at four to five years with the education of the mother and whether she played with the child. But, for Hidden Figures, there is a consistent relationship that suggests that children whose parents read to them tend to have higher scores. Children who have more Hidden Figures ability tend to get read to oftener and earlier.

Children whose fathers helped very much in their care had less incremental change than did children with less involved fathers (r = -.29). Finally, children reported as getting into things more than most had smaller increments than did other children. When increments from four to five were compared with questionnaire items, no significant relations emerged.

With regard to performance increments on Ambiguous Forms (ideas), Figure 2, there were no significant relations between three to five-year changes and questionnaire variables; for the four to five-year increments, similarly, there were none.

Increments in Ambiguous Forms (elaborations), Figure 3, at three to five years, were significantly related to the number of siblings--the more children in the home, the less the change (r = .34). Increments from four to five years were related to whether the father read to the child. The child read to had greater gains (r = .36).

Specifically, the education of the mother was not related to any of the age-related increments investigated. Thus, while education of the mother seems related to the level of verbal reasoning (increments in this factor could not be investigated), that characteristic is related neither to level nor to growth in originality or spatial transformation ability.

All in all, this was a disappointing set of results.

TABLE 13.

Varimax Rotation Analysis

Questionnaire, Five-Year-Olds

Rotated Factor Loadings

	1	2	3	4	5
1	.113	-.105	.203	.471	-.212
2	-.222	.371	.085	.089	-.143
3	.078	.495	.124	.073	-.142
4	.616	.171	.151	.004	.139
5	.728	.004	.164	-.018	-.125
6	.750	.037	.064	.172	.031
7	-.031	-.102	-.091	-.117	.324
8	-.004	.253	-.137	.431	-.097
9	-.027	-.156	.207	.046	.338
10	.209	.048	.656	.083	.024
11	.042	.268	.608	.009	.185
12	.165	.055	-.058	.513	.138
13	.078	.197	.041	.140	.427
14	.234	-.060	.001	-.339	.034
15	.047	-.102	.179	-.163	.351
17	-.044	-.135	.196	-.096	.140
20	-.121	-.093	-.247	.035	.031

TABLE 14.

Questionnaire (Five-Year-Olds) Varimax Rotation Analysis

	Variable	Loading	Questionnaire Item
Factor 1:	6	.75	Occupation of father
	5	.73	Education of father
	4	.62	Education of mother
Factor 2:	3	.50	Area
	2	.37	Sex
Factor 3:	10	.66	Father reads to child
	11	.61	Mother reads to child
	20	-.25	Pick up child when he cries
	17	.20	Number of traits causing anxiety
Factor 4:	12	.513	Father plays with child
	1	.471	Marital status--married
	8	.431	Number of children in the home
	14	-.339	Attended nursery school
Factor 5:	13	.427	Mother plays with child
	15	.351	Attends kindergarten
	9	.338	Kind of TV program watched
	7	.324	Occupation of mother

TABLE 15.

Factor Scores for Five-Year-Olds

Compared with Questionnaire Variables

Factors	NFS	DMI	NFU	CMS	NFT
Questionnaire Variable	1	2	3	4	5
1	-.095	-.087	.033	.139	.013
2	-.203	-.091	-.024	.133	.011
3	.073	-.216	-.178	.187	-.269
4	.080	-.026	.233	.106	.035
5	-.036	.001	.086	.106	.065
6	-.062	-.042	.071	.033	.059
7	.086	-.058	-.079	-.251	.061
8	-.072	-.168	-.125	-.046	.051
9	.044	-.059	-.055	-.090	.055
10	.171	.042	-.022	.109	.113
11	.086	.103	-.082	.036	.130
12	-.077	-.010	.100	.034	-.058
13	.015	-.047	-.063	-.013	-.010
14	.094	-.003	.107	.025	-.036
15	.087	.044	.165	.107	.108
17	-.076	.206	-.067	.073	-.006
20	.078	-.016	.152	.061	.152

FIGURE 1.

Hidden Figures

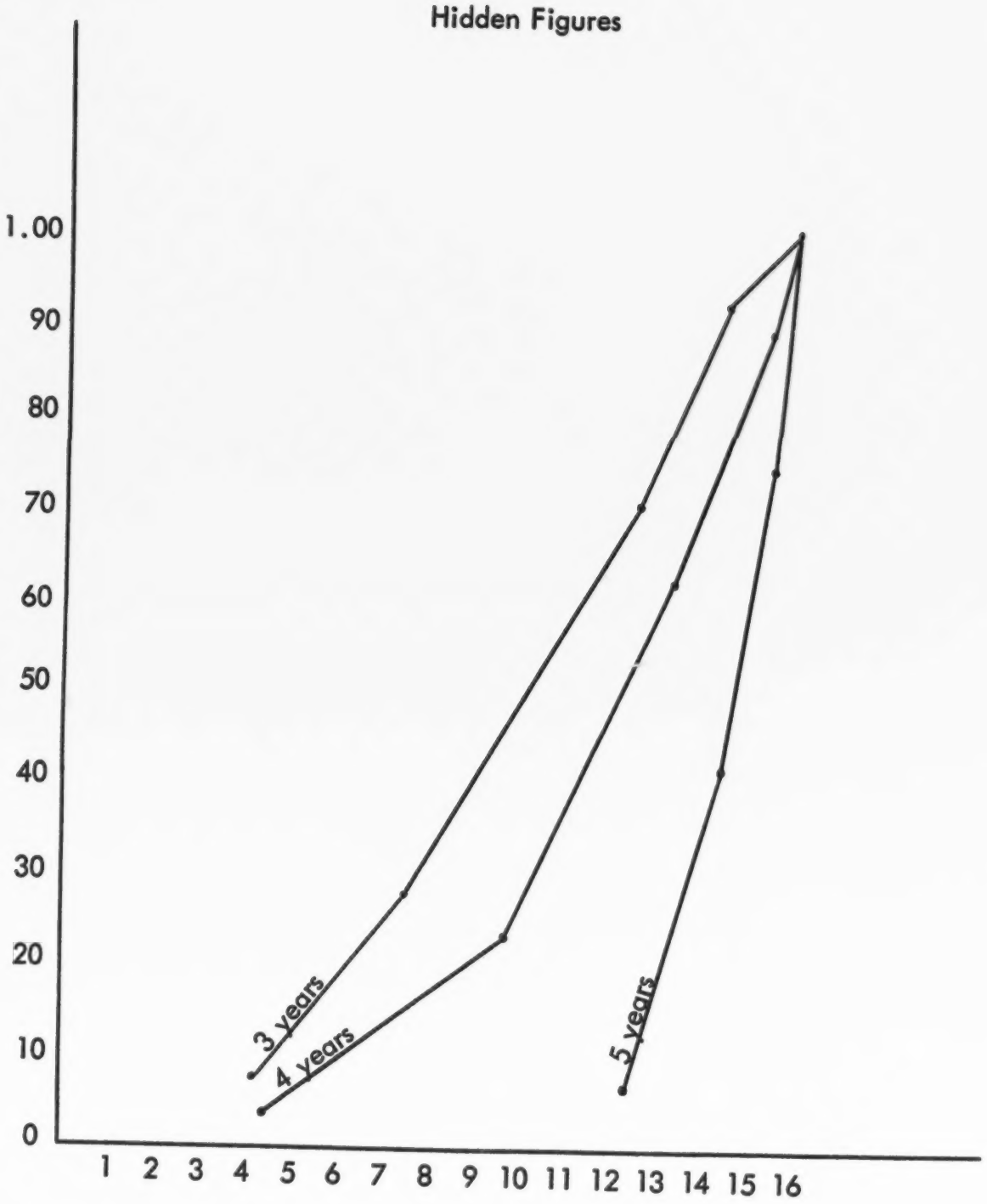


FIGURE 2.

Ambiguous Forms (Ideas)

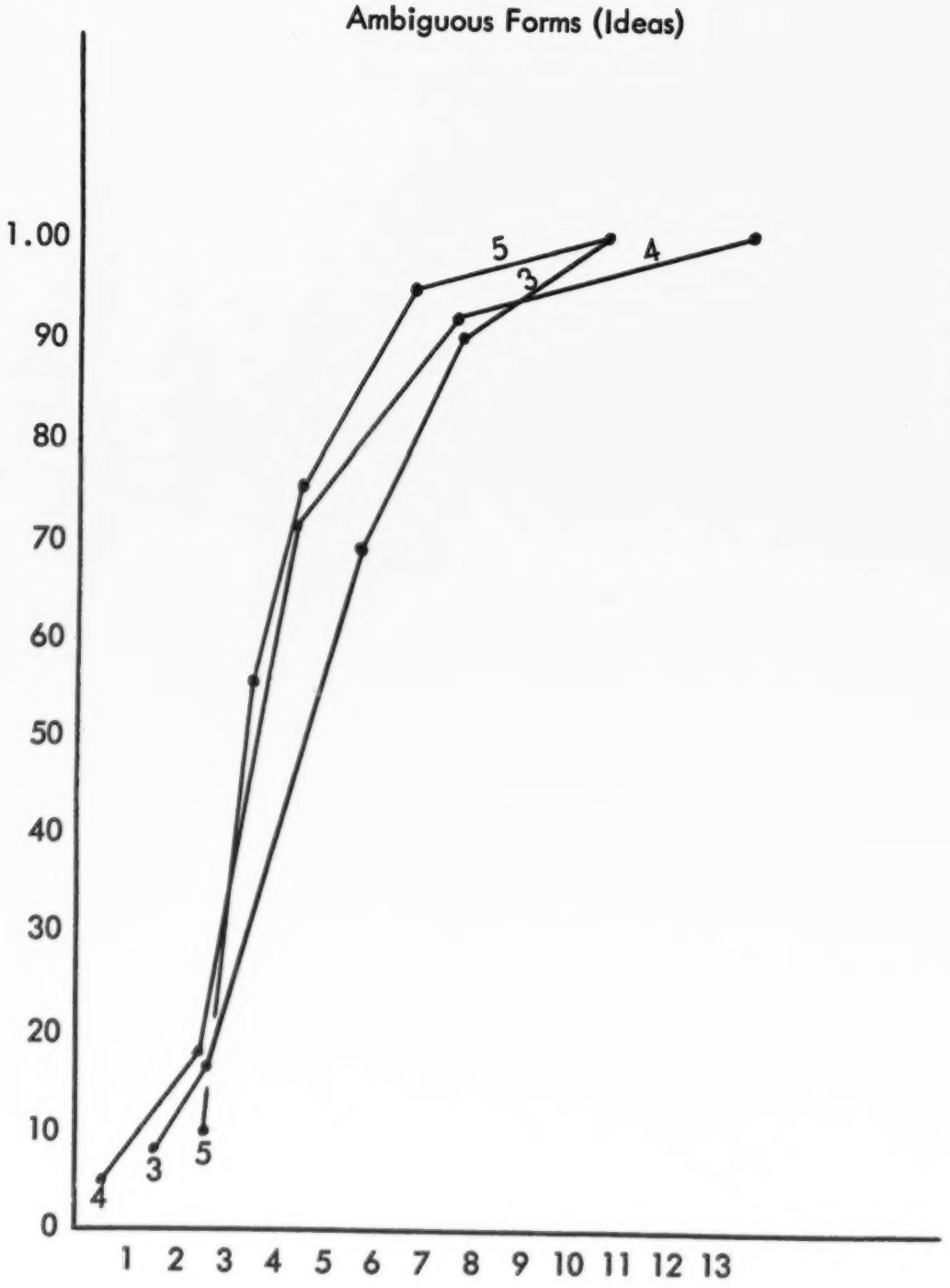
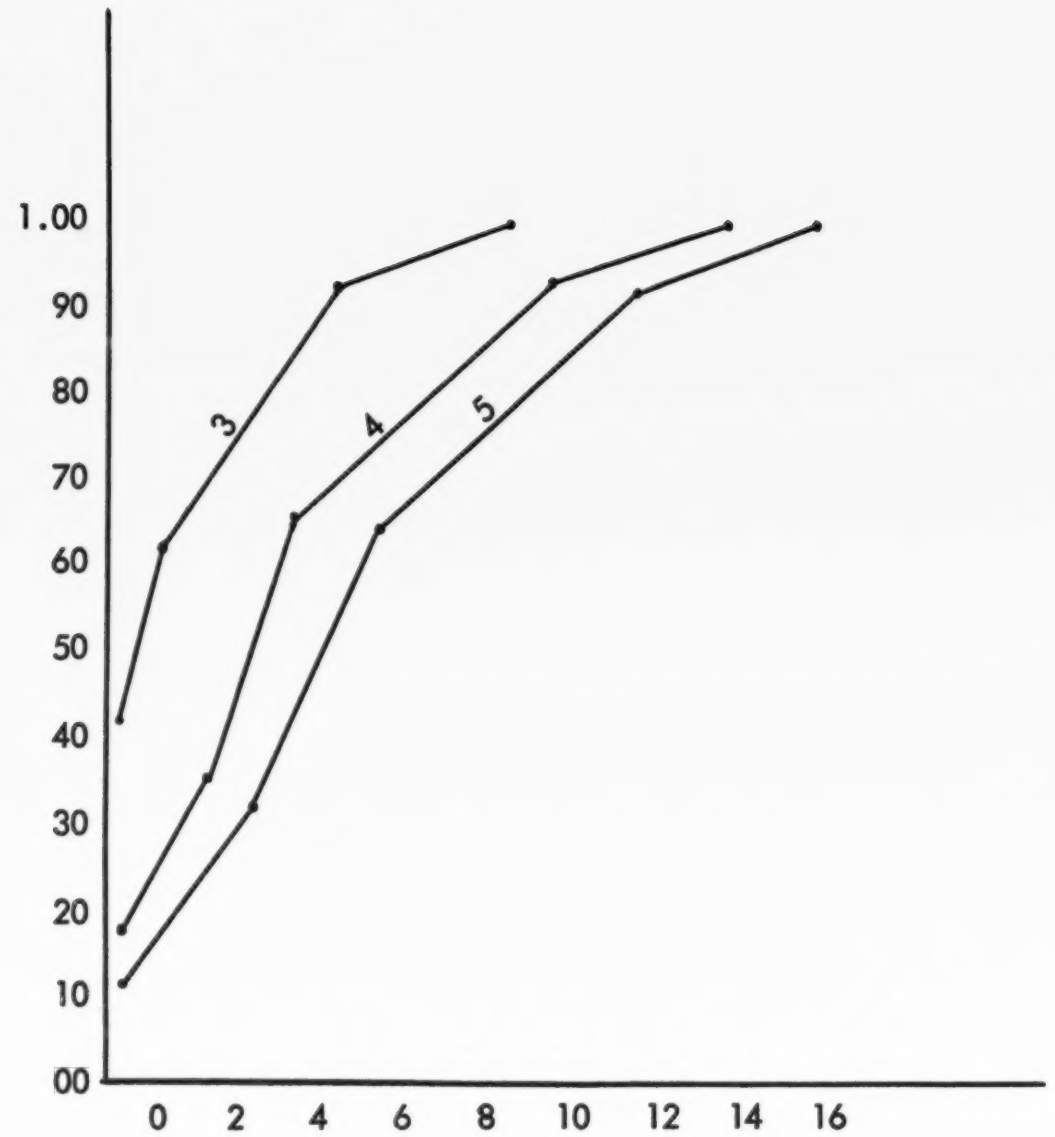


FIGURE 3.

Ambiguous Forms (Elaborations)



CONCLUSIONS AND IMPLICATIONS

In spite of a smaller number of cases, the factor findings for the three age levels is fairly consistent and agree with the earlier studies of three and four-year-old children where the number of cases is four to eight times as large. The patterns of thinking shown by preschool children are retained throughout the three-year age range.

However, the patterns of development of each child varies not only in general rate of change but also for each aptitude. The predictability of development for each child is very poor. It might be expected that children who do relatively better than their peers on a specific aptitude at age four will also maintain their relative superiority at age five. This expectation is definitely unconfirmed by these data. As has been shown earlier both by correlation of factor scores and the canonical correlation, the hope for a high level of prediction cannot be maintained for either ages three or four as to performances at age five, either in terms of a total score or for the separate aptitudes.

The most plausible explanation for this might be that, although children may be differentiated from each other with respect to the same dimensions at different stages in their development, individual development rates differ so that relative position in the peer group is not maintained longitudinally. Should this result be confirmed with larger samples, the implication is clear that "tracking" in school should be done frequently, and children should be reassigned to homogeneous groups for greater efficiency very often--in fact, so frequently that assignment to a "track" becomes meaningless.

A child may shift from a high group to a low group, or conversely, within a year, as a result of differences in developmental rates. These rates seem likely to differ from one aptitude to another so that a large increment in one aptitude over a short time does not imply anything about changes in other aptitudes. Thus, the clear implication is that assignment to a "track" from which he may never emerge is counter to the implications of these findings and results in a great waste of potential. One more bit of evidence is thus added to the need for individualized instruction.

Some of the potential causes for these differentials in the rate of development seem to lie in the different environmental influences upon the child's development. These differences affect differently the various aptitudes shown by the child. The education of the parents, particularly the mother, seems to be slightly related to how well the child learns to reason and to have a slight negative relation to his creative and imaginative tendencies. The more highly educated mothers also have children who tend to score higher on spatial construction ability. Working mothers tend to have children who reason less well.

Children whose parents are concerned about them tend to be more imaginative and fluent. The smaller number of children to a family tends to be related positively

to originality. Parents who read to the child, pick him up when he cries, and who are anxious about their child's personality characteristics have children who are more likely to have better developed spatial aptitudes. There seems to be no relationship between semantic aptitudes and the amount of time parents spend in reading to their children.

Many changes take place in the environment of the child during his childhood. His parents may become divorced, one parent may die, or a period of unemployment may change the home atmosphere completely. The parents may move to a different community changing playmates, household arrangements and schools. Illness may hit the family, one of the parents may have an accident, or the child may be affected seriously by an illness. The advent of a new baby, the mother deciding to work, leaving the child with baby-sitters, may so affect the child's emotional life that his behavior and rate of learning is altered greatly. Consequently, it is unrealistic to expect the rate of development for any one child to remain consistently the same. Certainly, it is unrealistic to expect children to have the same rate of development for different aptitudes.

The varying rates of development for groups of children have also other possible significance. The fact that children from homes having few or only children and parents who show concern about the child's personality development tend to exhibit more imaginative qualities than other children quite possibly means that the extra attention shown helps in producing imaginative aptitudes.

Another rather disturbing fact is that children whose mothers are either highly educated or from homes of high socioeconomic level show little development in divergent productive aptitudes in contrast to higher convergent productive development. The implication is that the preschool environment in the American culture does not provide optimum stimulation for the development of spontaneity, flexibility and originality of expression. This failure seems to be particularly evident in the homes of mothers who are college graduates. Socialization tends to emphasize the importance of giving the "right" answers, following directions, copying models. To live in the world as we know it may require conformity as the prime virtue and spontaneity and imagination are to be considered relatively minor values.

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